marine platform of varying width encircles the island, beyond which the water again deepens. Submarine profiles indicate that the island began its history as an orographic block, tilted to the north, and forming a part of the mainland. It stood 2000 to 3000 feet higher than at present. Following the tilting came the intrusions of porphyrite and diorite. Erosion made considerable progress upon this tilted block, and toward the close of this period the andesitic flows were erupted, accompanied by a slow subsidence. Santa Catalina became an island, depressed, at the close of the downward movement, 1400 to 1600 feet below its present level. During the Miocene a long period of erosion reduced the unsubmerged portions to a peneplain. A gradual elevation of 1850 feet followed, with at least one pause in the movement. The last oscillation is exhibited in the present period of rapid sinking.

The discussion and exposition (very inadequately summarized in a review of this length) is in general admirable. Exception might, however, be taken to the statement, made twice within the paper, that the shortening of a stream's course by the drowning of its lower reaches will cause it to cut down into its alluvial fan.

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Geology of the Castle Mountain Mining District, Montana. By W. H. WEED and L. V. PIRSSON. Bull. U. S. Geol. Surv., No. 139, pp. 164, 7 plates. Washington, 1896.

Recently considerable study has been directed to the isolated mountains which form the foothills of the Rockies. Such mountain masses offer an inviting field, since they are usually much simpler than the main ranges, and by working out in detail the history of such independent centers of eruption the general order and, perhaps, the causes of differentiation in rock magmas seem likely to be easiest learned.

The Castle Mountain is a dissected volcano, now rising about 3600 feet above the surrounding plain, itself having an altitude of about 5000 feet. The mountain mass is about ten miles in diameter, and stands in central Montana between the Little and Big Belt Mountains. The stratified rocks of the region include representatives of the Algonkian, Cambrian, Silurian, Devonian, Carboniferous, Jurassic, and Cretaceous, preceding the eruption, and certain Neocene lake

beds and glacial drift later than it. The rocks had been folded and eroded before the eruption began, but have been little disturbed since. In general the igneous rocks represent the types resulting from the differentiation of a granitic magma. The more abundant rocks are highly siliceous and rich in alumina and the alkalies. They include granite, granite-porphyry, quartz-porphyry, rhyolite, rhyolitic-obsidian, rhyolitic tuffs and breccias. More basic rocks, including augite-diorite, porphyries, passing into porphyrites, lamprophyric dikes and bosses and basalt flows occur in less abundance. The rocks belong to five groups: (1) The massive plutonic rocks represented by the main mass which is a miraolitic granite becoming porphyritic at the edge, and a second smaller mass, which is dioritic. The latter becomes a quartz-diorite-porphyrite at the edge, and is cut by aplitic dikes, probably from the granite mass. (2) The porphyritic rocks of the intruded sheets and flows include among the acid types micro-granite, quartz-porphyry, granite-porphyry, feldspar-porphyry and porphyrites. The basic types are lamphrophyric rocks, with phenocrysts of mica, augite, hornblende and olivine. Dikes are, upon the whole, rather rare, and in this particular the region stands in sharp contrast with the neighboring Crazy Mountain region. Minettes occur here as intruded masses and sheets rather than in the usual form of dikes. (3) The extrusive rocks include rhyolites and breccias from the granitic mass, and basalts in the region of Volcano Butte. (4) The tuffs and breccias have yielded largely to erosion, as would be expected, and now make up the Smith Lake beds. (5) There are certain igneous rocks in the region which do not seem to belong to this center of eruption. These include a diabase sheet intruded in the Belt shales (Algonkian), and presumably very ancient, certain ash deposits in the Dakota, and certain dikes of porphyrites, acmite-trachytes, trachytes and theralites of Crazy Mountain types.

The general order of eruption seems to have been: first, the diorite (possibly not belonging to the main mass); second, the granite; third, the rhyolite and pitchstone; and, fourth, the basalt and basic dikes. It will be seen that the rocks became successively more highly differentiated. The excellent analyses show that the alkali ratio K_2O : Na_2O is about 1 : 1.55 — 1 : 1.30, with the most rapid variation at the extremes. This ratio is independent of geologic position or coarseness of crystallization, and seems to be characteristic of the magma. A number of interesting petrographical facts are brought out in the

discussion of the rocks. Certain included masses in the granite, apparently resembling those common in orbicular granites, are shown to be fine-grained hornblende-mica-syenite, and it is suggested that their origin may be due to liquation. It is pointed out that the occasional reference of micropegmatitic structure to secondary changes as suggested by Irving, Hobbs, and Romberg, rests upon slight evidence and involves rather violent assumptions as to the method of corrosion.

Aplitic dikes carrying floated fragments of biotite and feldspar similar to the inclusions in the minette dikes at Aschaffenberg were noted. Ilmenite was found altering to leucoxene, which proved to be anatase rather than titanite. A quartz-tourmaline-porphyry is described. The rock occurs as an intruded sheet having a felsitic groundmass, quartz phenocrysts, feldspar flecks, and radial and stellate groups of fibrous tourmaline. It carries fluorite, and is referred to pneumatolitic processes. Among the lamprophyres are augite-vogesites, minettes and monchiquites. The latter are of interest as occurring here in connection with a granitic mass rather than with eleolite-syenite. In connection with this description of the monchiquites is given a note by Kemp correcting an analysis of a similar rock published by him in Bull. U. S. G. S. 107. The basalt carries occasional quartz, but offers no new evidence as to its primary or secondary origin. It is pointed out that the term divitrification, as used in petrography, does not necessarily mean strictly secondary action, since certain spherulites are produced in the process of cooling and while the rock is still viscous. Johnston-Lavis' theory that the variation in rocks is produced by the solvent action of the magma upon the conduit is shown to be untenable so far as this area at least is concerned. The molecular ratio between the alkalies of the most basic and most acid rocks of the series is 125 : 50. This would then require for the production of the latter the solution of at least an equal bulk of rock wholly free from alkali. Furthermore, the acid rocks which, according to the theory, should be first erupted was not first but relatively late. Finally, the dioritic mass, erupted through very basic shales, becomes more acid rather than more basic towards the periphery.

The report is well illustrated, and is of interest, not only from the fact that it deals with a hitherto practically unknown area, but because of the light shed by it upon these more general problems.

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